



Estimation of correlation and path coefficient analysis in selected okra genotypes

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Abstract— The experiment was undertaken to study the association among yield and its contributing traits and to assess their direct and indirect effects on fruit yield in okra. Thirty okra genotypes were evaluated in a randomized block design with three replications at the Vegetable Research Farm, CCS Haryana Agricultural University, Hisar, Haryana, India during kharif 2021. Genotypic correlation coefficients were generally higher than phenotypic correlation coefficients. Fruit yield/plant exhibited significant positive correlation with plant height (0.63, 0.43), number of branches per plant (0.66, 0.33), petiole length (0.56, 0.42), fruit length (0.75, 0.43) and fruit diameter (0.34, 0.20) at genotypic and phenotypic levels, respectively, while it showed significant negative correlation with days to 50% flowering (-0.82, -0.60), inter-nodal length (-0.67, -0.49) and first fruiting node (-0.63, -0.47). Path coefficient analysis revealed that fruit length exerted the highest positive direct effect on fruit yield per plant (0.76), followed by number of branches per plant (0.25) and number of fruits per plant (0.19). Plant height exhibited positive indirect effects via days to 50% flowering and first fruiting node. The study indicated that fruit length, number of branches per plant and number of fruits per plant are key traits for improving fruit yield in okra and should be emphasized in selection programmes.



Keywords— Okra, genotypic correlation coefficient, phenotypic correlation coefficients, path analysis, direct effect, indirect effect

I. INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) belongs to the family Malvaceae and is widely cultivated in tropical and sub-tropical regions of the world (Shivaramgowda et al., 2016). Okra is believed to have originated in Ethiopia, Sudan, and Northeast Africa and is now extensively grown in many countries (Salih and Mansoor, 2019). It is an annual, hardy, erect, and high-yielding vegetable crop showing wide variation in plant size, pod shape, pigmentation, branching habit, maturity period, and plant height (Purquerio et al., 2010). Okra is a polyploid crop with chromosome numbers of $2n = 8x = 72$ or 144 and is commonly known as lady's finger in many English-speaking countries. Among *Abelmoschus* species, *A. angulosus* has the lowest chromosome number ($2n = 56$), whereas *A. caillie* possesses the highest chromosome number ($2n = 200$) (Singh and Bhatnagar, 1975). The fresh and immature fruits of okra are used as a vegetable and are

valued for their high nutritive and medicinal properties. Okra fruits are rich in carbohydrates, fibre, calcium, phosphorus, iron, magnesium, iodine, and vitamins A, B, and C (Samim et al., 2018). Okra mucilage has medicinal importance and has been reported to act as a blood volume expander, reduce proteinuria, and alleviate renal disorders (Siemonsma and Kouame, 2004). Its alkaline nature helps in neutralizing digestive acids and relieving gastrointestinal ulcers. The stem bark and fibres are used in rope making, paper, and cardboard manufacturing. Mucilage obtained from soaked roots and stems is traditionally used for clarifying sugarcane juice during jaggery preparation. Okra is a heat- and drought-tolerant crop but is sensitive to cold stress (Reddy et al., 2013). The optimum temperature ranges for growth, flowering, and pod development is reported to be 21–30 °C. Before initiating any crop improvement programme, assessment of genetic variability among parental material is essential (Das et al., 2012).

Greater variability enhances the efficiency of selection for desirable traits. Genetic variability plays a crucial role in selecting elite genotypes and identifying suitable parents for hybridization. Yield is a complex quantitative trait governed by several yield-attributing characters. Therefore, understanding the association among yield and its component traits is essential for formulating effective breeding strategies (Aminu et al., 2016). Correlation analysis helps identify traits contributing to yield improvement, while genotypic correlations reflect inherent associations and phenotypic correlations include environmental effects (Johnson et al., 1955). Path coefficient analysis further partitions correlation coefficients into direct and indirect effects, enabling precise identification of traits influencing yield (Dewey and Lu, 1959). Considering these aspects, the present investigation was undertaken to study the association among yield-related traits and their direct and indirect effects on fruit yield in okra genotypes using path coefficient analysis.

II. MATERIAL AND METHOD

The experiment was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana

Agricultural University, Hisar which is located in the subtropics at 29° 10' North latitude and 75° 46' East longitude, during *kharif* 2021. Thirty genotypes were evaluated in field experiment (Table-1.0). The experiment was designed as Randomized Block Design (RBD) with three replications. The planting distance was 60 cm × 30 cm (60 cm between rows and 30 cm within row). Observations were recorded for quantitative characters. Five randomly chosen plants from each genotype and replication were used to collect the data. Observations recorded were plant height, branches per plant, days to 50% flowering, inter-nodal length (cm), first fruit node, fruit length (cm), fruit diameter (cm), fruit weight (g), fruits per plant, fruit yield per plant (g). The collected data were statistically analysed to determine path analysis (direct effect and indirect effect), genotypic and phenotypic correlation, and phenotypic correlation was utilised to determine path coefficient analysis. Correlation coefficients were calculated using the variance and covariance components, as proposed by (Al-Jibouri et al., 1958). Path coefficient analysis was performed using genotypic correlation values of yield components which was illustrated by (Dewey and Lu, 1959).

Table-1.0: List of genotypes used in the research experiment

Sr.	Genotypes	Source	Origin	Sr.	Genotypes	Source	Origin
1.	HB-9-35	CCS HAU, Hisar	India	16.	PrabhaniKranti	MAU, Prabhani	India
2.	HB-9-37	CCS HAU, Hisar	India	17.	HBT-11-1	CCS HAU, Hisar	India
3.	HB-9-38	CCS HAU, Hisar	India	18.	HBT-42	CCS HAU, Hisar	India
4.	HB-9-43	CCS HAU, Hisar	India	19.	HBT-49-1	CCS HAU, Hisar	India
5.	HBT-1	CCS HAU, Hisar	India	20.	HBT-15	CCS HAU, Hisar	India
6.	Punjab-8	PAU, Ludhiana	India	21.	JNDOL-05	AAU, Gujrat	India
7.	PusaSawani	IARI, New Delhi	India	22.	HB-691-08	CCS HAU, Hisar	India
8.	Punjab Padmini	PAU, Ludhiana	India	23.	HBTC-6-7-1	CCS HAU, Hisar	India
9.	HB-9-29	CCS HAU, Hisar	India	24.	HBT-53	CCS HAU, Hisar	India
10.	HB-06-46-1-1	CCS HAU, Hisar	India	25.	ArkaAbhay	IIHR, Bangalore	India
11.	HB-S-4	CCS HAU, Hisar	India	26.	HisarUnnat	CCS HAU, Hisar	India
12.	HB-25-2-1	CCS HAU, Hisar	India	27.	VarshaUphar	CCS HAU, Hisar	India
13.	HBBT-19	CCS HAU, Hisar	India	28.	Hisar Naveen	CCS HAU, Hisar	India
14.	HBT-48	CCS HAU, Hisar	India	29.	HB-9-27	CCS HAU, Hisar	India
15.	HB-08-3-1	CCS HAU, Hisar	India	30.	HBT-12-1	CCS HAU, Hisar	India

Table 2.0: Genotypic (above diagonal) and phenotypic correlation coefficients (below diagonal) among different characters in okra

Characters	PH (cm)	BPP	DFF	PL (cm)	INL (cm)	FFN	FL (cm)	FD (cm)	FW (g)	FPP
PH (cm)	1.00	0.49**	-0.62**	0.52**	-0.44**	-0.41**	0.44**	0.37**	-0.01 ^{NS}	0.40**
BPP	0.78**	1.00	-0.47**	0.46**	-0.30**	-0.33**	0.38**	0.27*	0.14 ^{NS}	0.17 ^{NS}
DFF	-0.84**	-0.79**	1.00	-0.44**	0.35**	0.45**	-0.28**	-0.29**	-0.16 ^{NS}	-0.38**
PL (cm)	0.61**	0.67**	-0.47**	1.00	-0.47*	-0.35*	0.44**	0.22*	0.05 ^{NS}	0.40**
INL (cm)	-0.70**	-0.66**	0.73**	-0.85**	1.00	0.35**	-0.45**	-0.33**	-0.18 ^{NS}	-0.46**
FFN	-0.51**	-0.48**	0.64**	-0.45*	0.61**	1.00	-0.36**	-0.21*	-0.15 ^{NS}	-0.36**
FL (cm)	0.61**	0.49*	-0.44**	0.61**	-0.64**	-0.47**	1.00	0.11 ^{NS}	0.06 ^{NS}	0.37*
FD (cm)	0.56**	0.60**	-0.49*	0.40**	-0.71**	-0.31**	0.28**	1.00	0.10 ^{NS}	0.09 ^{NS}
FW (g)	0.03 ^{NS}	0.31**	-0.15 ^{NS}	0.07 ^{NS}	-0.47*	-0.24*	0.22*	0.33**	1.00	0.07 ^{NS}
FPP	0.77**	0.50**	-0.85**	0.77**	-0.87**	-0.55**	0.56**	0.17 ^{NS}	-0.11 ^{NS}	1.00

PH-Plant height, BPP - Branches per plant, DFF- Days to 50% flowering, PL- Petiole length, INL- Inter-nodal length, FFN- First fruit node, FL- Fruit length, FD- Fruit diameter, FW- Fruit weight, FPP- Fruits per plant

III. RESULT AND DISCUSSION

Correlation coefficients analysis

Correlation coefficients were worked out at phenotypic and genotypic levels to estimate the degree of association among various characters. The results of correlation analysis have been presented in Table 2.0. In almost all the traits the estimate of genotypic correlation coefficients was higher than phenotypic correlation coefficients, thus demonstrating a strong inherent association between various traits. These findings were found in accordance with Niranjana et al., (2004), Somashekhar et al., (2011), Badiger et al., (2017)

Yield per plant showed significant positive correlation with plant height (0.63, 0.43), branches per plant (0.66, 0.33), petiole length (0.56, 0.42), fruit length (0.75, 0.43), fruit diameter (0.34, 0.20^{NS}), number of fruits per plant, whereas significant negative correlation with days taken to 50% flowering (-0.82, -0.60), inter-nodal length (-0.67, -0.49), first fruit node (-0.63, -0.47), at both genotypic and phenotypic levels respectively. The results obtained from study are in confirmation with Reddy et al., (2013). Similar results were obtained by Gogineni et al., (2015), Kumar and Reddy (2016), Kerure et al., (2017) for number of fruits per plant; Gogineni et al., (2015), Kumar & Reddy (2016), Yadav et al., (2017) for plant height at final harvest; Shivaramgowda et al., (2016), Kerure et al., (2017), Nirosha et al., (2014), for number of branches/plant;

Shivaramgowda et al., (2016), Kerure et al., (2017), Sundaram V (2015) for fruit diameter.

Fruits per plant exhibited significant positive association with plant height (0.77, 0.40), branches per plant (0.50, 0.17), petiole length (0.77, 0.40), fruit length (0.56, 0.37), yield per plant (0.90, 0.38); Significant, negative correlations expressed with days taken to 50% flowering (-0.85, -0.38), inter-nodal length (-0.87, -0.46), first fruit node (-0.55, -0.36), at both genotypic and phenotypic levels, respectively. Fruits per plant positively correlated with branches per plant; confirmation with Verma & Singh, (2020).

Fruit length has depicted positive and significant correlation with plant height (0.61, 0.44), branches per plant (0.49, 0.38), petiole length (0.61, 0.44), fruits per plant (0.56, 0.37), yield per plant (0.75, 0.43) and significant negative correlation with days taken to 50% flowering (-0.44, -0.28), inter-nodal length (-0.64, -0.45), first fruit node (-0.47, -0.36), fruit diameter (-0.28, -0.11), at both genotypic and phenotypic levels respectively. Fruit length was positively correlated with plant height; confirmation with Saryam DK (2012) and Ghosh JS, (2005). Fruit diameter exhibited significant positive correlation with plant height (0.56, 0.37), branches per plant (0.60, 0.27), petiole length (0.40, 0.22) and significant, negative correlation with days taken to 50% flowering (-0.49, -0.29), first fruit node (-0.31, -0.21) and fruit length (-0.28, -0.11), at both genotypic and phenotypic levels respectively.

Plant height exhibited significant positive correlation with branches per plant (0.78, 0.49), petiole length (0.61, 0.52) fruit length (0.61, 0.44), fruit diameter (0.56, 0.37), fruits per plant (0.77, 0.40), yield per plant (0.63, 0.43); Significant, negative correlation with days taken to 50% flowering (-0.84, -0.62), inter-nodal length (-0.70, -0.44) and first fruit node (-0.51, -0.41) at genotypic and phenotypic levels respectively. The results obtained from study are in confirmation with Reddy et al., (2013) and Ahamed et al., (2015).

Branches per plant exhibited significant positive correlation with plant height (0.78, 0.49), petiole length (0.67, 0.46), fruit length (0.49, 0.38), fruit diameter (0.60, 0.27), fruits per plant (0.50, 0.17^{NS}), yield per plant (0.66, 0.33); Significantly negative correlated with days to 50% flowering (-0.79, -0.47) and inter-nodal length (-0.66, -0.30), at genotypic and phenotypic levels respectively. Similar results are also reported by Nirosha et al., (2014).

Days taken to 50% flowering exhibited significant positive correlation with inter-nodal length (0.73, 0.35), first fruit node (0.64, 0.45); significant positive correlated

with plant height (-0.84, -0.62), branches per plant (-0.79, -0.49), petiole length (-0.47, -0.44), fruit length (-0.44, -0.28), fruit diameter (-0.49, -0.29), fruits per plant (-0.85, -0.38) and yield per plant (-0.82, -0.60), at both genotypic and phenotypic levels respectively.

Inter-nodal length indicated significant positive relationship with days taken to 50% flowering (0.73, 0.35), first fruit node (0.01, 0.35) and significant negative correlation with plant height (-0.70, -0.44), branches per plant (-0.66, -0.30), petiole length (-0.85, -0.47), fruit length (-0.64, -0.45), fruit diameter (-0.71, 0.33), fruits per plant (-0.87, -0.46) and yield per plant (-0.67, -0.49), at both genotypic and phenotypic levels respectively.

Path coefficients analysis

The path coefficients were computed using the corresponding values of genotypic correlation coefficients, by taking the yield as dependent variable and rest all the characters as independent variable to evaluate and quantify direct as well as indirect effects of contributing characters on yield. The resulted values of path coefficients analysis are depicted in Table 3.0.

Table 3.0: Path coefficients analysis (direct and indirect effect) for different characters in okra

Characters	PH (cm)	BPP	DDF	PL (cm)	INL (cm)	FFN	FL (cm)	FD (cm)	FW (g)	FPP
PH (cm)	-0.99	0.20	1.00	-0.13	0.39	-0.04	0.46	-0.08	-0.01	-0.14
BPP	-0.77	0.25	0.94	-0.15	0.37	-0.04	0.37	-0.09	-0.12	-0.09
D50%F	0.84	-0.20	-1.18	0.10	-0.41	0.06	-0.33	0.07	0.06	0.16
PL (cm)	-0.61	0.17	0.56	-0.22	0.48	-0.04	0.47	-0.06	-0.03	-0.14
INL (cm)	0.70	-0.17	-0.86	0.19	-0.56	0.05	-0.49	0.11	0.19	0.16
FFN	0.51	-0.12	-0.76	0.10	-0.34	0.09	-0.36	0.04	0.09	0.10
FL (cm)	-0.60	0.12	0.52	-0.13	0.36	-0.04	0.76	-0.04	-0.09	-0.10
FD (cm)	-0.56	0.15	0.58	-0.08	0.40	-0.03	0.21	-0.15	-0.13	-0.03
FW (g)	-0.03	0.08	0.18	-0.01	0.26	-0.02	0.16	-0.05	-0.41	0.02
FPP	0.77	0.13	1.01	-0.17	0.49	-0.05	0.43	-0.02	0.04	0.19

PH-Plant height, BPP - Branches per plant, DDF- Days to 50% flowering, PL- Petiole length, INL- Inter-nodal length, FFN- First fruit node, FL- Fruit length, FD- Fruit diameter, FW- Fruit weight, FPP- Fruits per plant

Direct effects

Results from path coefficients analysis showed that highest positive direct effect towards yield per plant was contributed by fruit length (0.76) followed by branches per plant (0.25) and fruits per plant (0.19). However, highest negative direct effect towards yield per plant was indicated by days taken to 50% flowering (-1.1) followed by plant height (-0.99), inter-nodal length (-0.56), fruit weight (-0.41), petiole length (-0.22) and fruit diameter (-0.15). Number of fruits per plant had positive direct effect

on yield per plant. These results are in confirmation with result of Syfullah et al., (2018), Ashraf et al., (2020). Fruit per plant had positive direct effect via branches per plant, fruit length, fruit diameter. These results are in confirmation with Ashraf et al., (2020). Rathod et al., (2019) and Umesh et al., (2014) stated that branches per plant had a positive direct effect on fruit yield. Positive direct effect was found by Raval et al., (2019) between fruit yield/plant and fruit length. Similar results were reported by Kumar and Reddy (2016), Yadav et al., (2017), Sundaram V (2015), Umesh et

al., (2014) for fruit length. Direct selection practiced for fruit length will result in improvement in yield. Gogineni et al., (2015), Rathod et al., (2019) stated that plant height showed negative direct effect on fruit yield/plant.

Indirect effects

The observations from analysis depicted that plant height had a positive indirect effect on yield per plant via days taken to 50% flowering (0.84), first fruit node (0.51) and negative indirect effect via branches per plant (-0.77), fruits per plant (-0.77), fruit length (-0.60) and fruit diameter (-0.56). Branches per plant had a positive indirect effect on yield per plant via branches per plant (0.25), plant height (0.15), fruit length (0.12), fruit diameter (0.15), fruit yield per plant and negative indirect effect via days taken to 50% flowering (-0.20) and inter-nodal length (-0.17). Days taken to 50% flowering had a positive indirect effect on yield per plant via plant height (1.00), branches per plant (0.94), fruits per plant (1.01), fruit diameter (0.58), fruit length (0.52) and negative indirect effect via inter-nodal length (-0.86) and first fruit node (-0.76). Similarly, petiole length had a positive indirect effect on yield per plant via days taken to 50% flowering (0.10), inter-nodal length (0.19) and negative indirect effect via fruits per plant (-0.17), branches per plant (-0.15), fruit length (-0.13) and plant height (-0.13). Inter-nodal length had a positive indirect effect on yield per plant via fruits per plant (0.49), fruit diameter (0.40), plant height (0.39), branches per plant (0.37), fruit length (0.36) and negative direct effect via days taken to 50% flowering (-0.41) and first fruit node (-0.34). First fruit node had positive indirect effect on yield per plant via inter-nodal length (0.05) and negative indirect effect via fruits per plant (-0.05), branches per plant (-0.04), plant height (-0.04) and fruit diameter (-0.03). First length had positive indirect effect on yield per plant via plant height (0.46), fruits per plant (0.43), branches per plant (0.37), fruit diameter (0.21), fruit weight (0.16) and negative indirect effect via inter-nodal length (-0.49), first fruit node (-0.36) and days taken to 50% flowering (-0.33). Fruit diameter had positive indirect effect on yield per plant via inter-nodal length (0.11) and negative indirect effect via plant height (-0.08), branches per plant (-0.09), fruit weight (-0.05), fruit length (-0.04) and fruits per plant (-0.02). Fruit weight had positive indirect effect on yield per plant via first fruit node (0.09), days taken to 50% flowering (0.06), yield per plant (0.04) and negative direct effect via branches per plant (-0.12) and fruit diameter (-0.13). Fruits per plant had positive indirect effect on yield per plant via days taken to 50% flowering (0.16), inter-nodal length (0.16), first fruit node (0.10), fruit weight (0.02) and negative indirect effect via plant height (-0.14), fruit length (-0.10), branches per plant (-0.09) and fruit diameter (-0.03). The indirect negative effect of trait was also observed via fruit length. First fruit node

had negative indirect effect was through fruit length. These results were also similar to Ariyo et al., (1987).

IV. CONCLUSION

For most of the characters studied, genotypic correlation coefficient estimates were higher than phenotypic correlation coefficient estimates. The fruit yield per plant (g) depicts a significantly positive correlation with number of branches per plant, plant height, petiole length, fruit length, fruit diameter and number of fruits per, which indicated that selection of plants may be done based on these traits per plant. Highest positive direct effect towards yield per plant was attributed by branches per plant (0.25), fruit length (0.76) and first fruit node (0.09). Days taken to 50% flowering had a positive indirect effect on yield per plant mainly via fruits per plant (0.16). The total number of fruits per plant, fruit length, fruit weight, branches per plant and inter-nodal length proved to be the most propitious characters influencing the yield directly as well as indirectly.

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